Name of Institute: Indus Institute of Technology and Engineering

Name of Faculty: Prof. Hinal Shah

Course code: EL0419

Course name: Control Theory

Pre-requisites: Laplace transform, Linear Algebra, Differential Equations

Credit points: 04

Offered Semester: 4th

Course Coordinator (weeks 01-15)

Full Name: Hinal Shah

Department with siting location: 3rd floor Staff room, Bhanwar Building

Telephone: 9727554848

Email: hinalshah.el@indusuni.ac.in

Consultation times: Tuesday: 3:25-4:15

Course Lecturer (weeks 01-15)

Full name: Hinal Shah

Department with siting location: 3rd floor Staff room, Bhanwar Building

Telephone: 9727554848

Email: hinalshah.el@indusuni.ac.in

Consultation times: Tuesday: 3:25-4:15

Students will be contacted throughout the Session via Mail with important information relating to this Course.

Course Objectives

By participating in and understanding all facets of this Course a student will:

1) To learn the different types of control systems and its modeling
2) To understand time response characteristics of system
3) To know Time domain stability.
4) To know frequency domain stability.

Course Outcomes (CO)

CO1: Design mathematical model of electrical, mechanical and liquid level system. [BT-6]

CO2: Determine transfer function of the system using block reduction and Signal Flow techniques. [BT-3]

CO3: Analysis of Transient response of first order and second order control system. [BT-4]

CO4: Calculate steady state error for TYPE 0, 1, and 2 systems. [BT-3]

CO5: Evaluate stability using Routh- Hurwtiz criterion and root locus. [BT-5]

CO6: Test and Analyse stability in Frequency domain using Nyquist, Polar and Bode Plot. [BT-5]

Course Outline

UNIT-I **[11]**

Introduction

Introduction, Open-loop system and its examples, Closed-loop system and its examples, Open-loop vs Closed-loop.

Mathematical Modeling Modeling of Mechanical system, Modeling of Electronic and electrical system, modeling of Liquid-level system, Transfer function of system, Modeling in state-space.

UNIT-II **[11]**

Block diagram and Signal Flow graph

Block diagram formulation, Block diagram reduction, Signal Flow graph, Mason's Gain formula

Transient response analysis

Standard test signals, First-order and second order systems, higher order systems, Transient response of system.

UNIT-III **[12]**

Steady State Response Analysis:

Steady-state error for unit, ramp and parabolic inputs, Effect of Proportional, derivative and integral control, MATLAB simulations.

Time domain Stability Analysis

RH stability criteria, Introduction to Root Locus, Rules for constructing the root locus, System analysis with the help of Root-locus, Root-locus plot using MATLAB.

UNIT-IV **[11]**

Frequency Response Analysis

Introduction, Specification for frequency response, Polar-plots, Bode plots, Nyquist plots, Stability analysis, MATLAB simulations

Method of delivery

Face to face lectures

Study time

3 Hours Lecture and 2Hours Laboratory per week

CO-PO Mapping (PO: Program Outcomes)

	PO1	PO 2	PO3	PO4	PO5	PO 6	PO7	PO 8	PO 9	PO 10	PO1 1	PO 12
CO1	2	3	2	1	-	-	-	-	-	-	-	-
CO2	2	3	2	-	-	-	-	-	-	-	-	-
CO3	2	3	2	2	1	-	-	-	2	-	-	-
CO4	3	3	2	2	-	-	-	-	-	-	-	-
CO5	3	2	3	2	-	-	-	-	2	-	-	-
CO6	2	3	3	2	1	-	-	-	2	-	-	-
EL0419	**2.3**	**2.8**	**2.3**	**1.8**	**1**	**-**	**-**	**-**	**2**	**-**	**-**	**-**

1-Lightly Mapped 2- Moderately Mapped 3- Highly Mapped

Blooms Taxonomy and Knowledge retention (For reference)

(Blooms taxonomy has been given for reference)

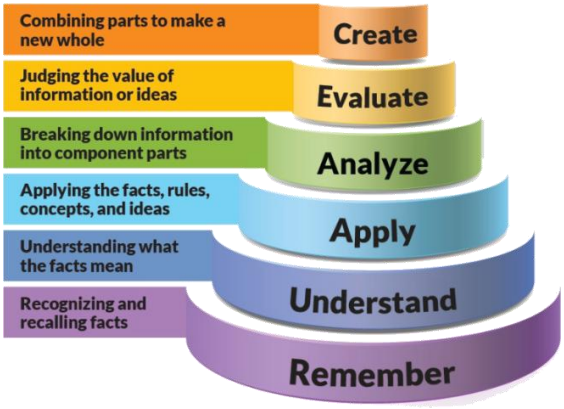


Figure 1: Blooms Taxonomy

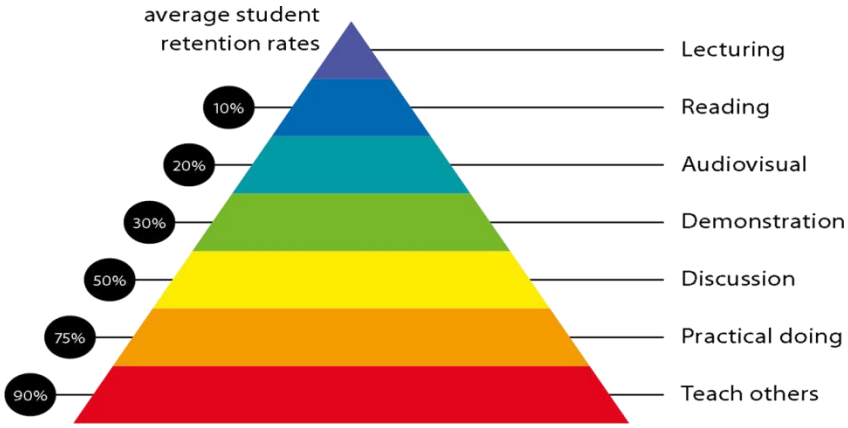


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of Electrical Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, and innovative and aim for high standards.	**4 Problem solving skills**

Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication**
	6 Oral communication
	7 Teamwork
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:

1.	To verify the operation of Open loop control system.
2.	To verify the operation of Type "0" Control System.
3.	To verify the operation of Type "1" Control System.
4.	To verify the operation of Type "2" Control System.
5.	Introduction of Control System Toolbox commands and obtained the first order and second order response for the different inputs.
6.	Feedback system simulation in MATLAB
7.	Obtained Time response characteristics.
8.	Root locus design in MATLAB
9.	Stability analysis on Bode/Nyquist plots in MATLAB
10.	Simulation of close loop control system in MATLAB Simulink.

Lecture/Lab times

(Give lecture times in the format below)

Lecture: Laboratory:

seminars and practical work as stipulated in the Course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for mid and end semester examinations.

Details of referencing system to be used in written work

Text books

1. Katsuhiko Ogata, “Modern Control Engineering”, 4th Ed, Prentice Hall of India.
2. Benjamin C.Kuo, “Automatic Control Systems”, John Wiley & Sons

Additional Materials

Reference books

1. Norman S Nise, “Control system Engineering”, 4th Ed., Wiley-India Edition
2. I J Nagrath, M Gopals “Control system Engineering”, 5th Ed.,

Web Resource

1) www3.imperial.ac.uk
2) mitra.ac.in
3) www.nptel.ac.in

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

Class test (MSE) (40 marks) Assignment (10 marks) Innovative/Project/Presentation (10 marks) Final exam (*closed book*) (40 marks)

Su

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in mid semester or end semester will be considered for supplementary assessment in the respective components (i.e mid semester or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (mid semester or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Practical Work Report/Laboratory Report:

A report on the practical work is due the subsequent week after completion of the class by each group.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of 5% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

Do not copy the work of other students.

Do not share your work with other students (except where required for a group activity or assessment)

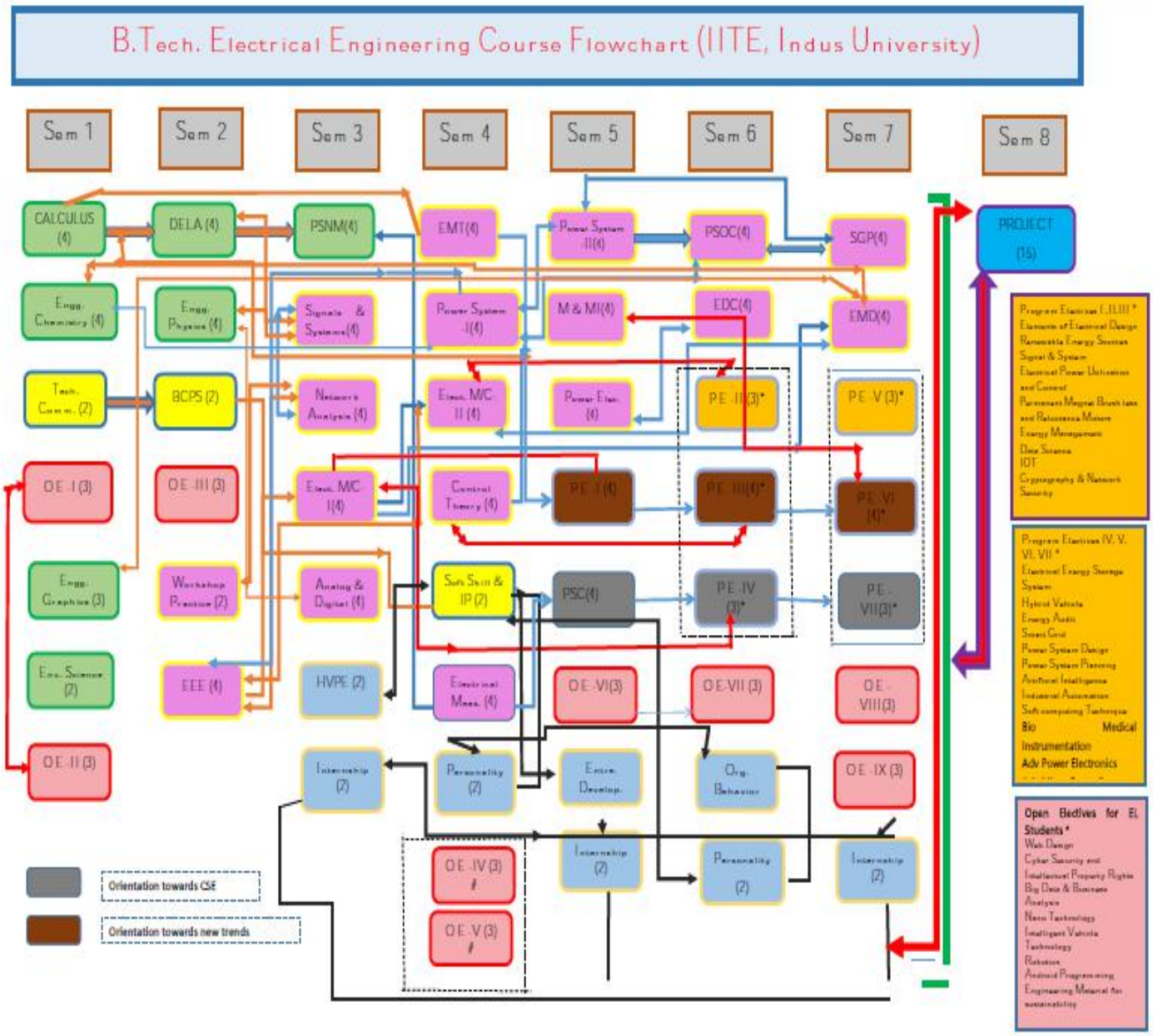
Course schedule (subject to change)

(Mention quiz, assignment submission, breaks etc as well in the table under the Teaching Learning Activity Column)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	Introduction to Control System and classification of control system, Open-loop system and Closed-loop system and its examples, Open loop vs Closed-loop, Transfer Function, Properties of T.F, Poles and Zeros of T.F., Transfer function of electrical system.	1,2	*BB, PPT*
	Weeks 2	Mechanical systems with translational motion, modeling, example – Force-voltage and Force-current analogy, Free body diagram, Mechanical systems with Rotational motion, modeling, example – Torque- Voltage and Torque-current analogy. Lever Pully and Gear Train Mechanism, Modeling of Liquid-level system.	1,2	*BB*
	Week 3	Modeling in state-space, State Variables, Block diagram formulation, reduction technique, examples, Signal flow graph, Mason's gain formula examples	1,2	*BB*
	Week 4	Electrical /Mechanical Circuit Transfer function using Signal flow, Standard test signals-step, ramp, impulse, order of system, Time response- Transient response of 1st order system - unit step response, unit ramp response	2,3,4	*BB*
	Week 5	Unit impulse response of 1st order system, Time response of Second order system- under damped, over damped, critically damped, un-damped, Time response of Second order system- over damped	3,4	*BB*

	Week 6	Time response of Second order system-critically damped, un-damped, Time response specifications of 2nd order-derive rise time, peak time, ts, td, Mp, examples, Steady state error, error constants	3,4	*BB*
	Week 7	Define Kp, Kv, Ka, Derive steady state error for the step, ramp and parabolic input for type-0, Derive steady state error for the step, ramp and parabolic input for type-1, Derive steady state error for the step, ramp and parabolic input for type-2	3,4	*BB, PPT*
	Week 8	Stability of the system, necessary conditions for stability, Different nature of response for diff. types of roots, Hurwitz Stability criteria and Example.	3,4,5	*BB*
	Week 9	Routh array (Routh-Hurwitz) stability criteria, Auxiliary Equation, Examples of RH stability, find range of k for stability, Advantages and disadvantages of RH criterion, Effect of Proportional control, Derivative Control, Integral Control.	5,6	*BB*
	Week 10	PI, PD, PID Examples of P, I, D, PI, PD, PID control, Introduction to Root locus, Steps for solving root locus, Rules for constructing the root locus, angle and magnitude criterion, System analysis with the help of Root-locus, Examples of Root Locus	5,6	*BB*
	Week 11	Steps for solving root locus, Rules for constructing the root locus, angle and magnitude criterion, System analysis with the help of Root-locus, Examples of Root Locus	5,6	*BB*
	Week 12	Construction of Root Locus example, Introduction to frequency response, Specifications, Bode Plot Introduction, first order, second order pole – zero mapping in Bode Plot.	5,6	*BB*

	Week 13	Specifications-Phase Margin, Gain Margin, bandwidth, cut-off frequency, cut-off rate, resonant frequency, gain crossover, phase crossover, phase margin angle, and system stability using Bode plot, Example of Bode Plot	6	*BB*
	Week 14	Introduction to Polar plot, properties, advantages, disadvantages, Polar-plots of standard functions, Polar-plots Examples	6	*BB*
	Week 15	Introduction to Nyquist plots, Nyquist stability criterion, Steps to solve Nyquist plot, Nyquist Examples, Nyquist plots Examples	6	*BB*



Syllabus

Subject: Control Theory

Program: B.Tech. Electrical Engineering				Subject Code:EL0419				Semester: IV
Teaching Scheme				Examination Evaluation Scheme				
Lecture	Tutorial	Practical	Credits	University Theory Examination	University Practical Examination	Continuous Internal Evaluation (CIE)- Theory	Continuous Internal Evaluation (CIE)- Practical	Total
3	0	2	4	40	40	60	60	200

Perquisites:

1) Laplace transform
2) Linear Algebra
3) Differential Equations

Course Objectives:

1. To learn the different types of control systems and its modeling
2. To understand time response characteristics of system
3. To know Time domain stability.
4. To know frequency domain stability.

Course Outcome:

1. Learn the basic concepts of linear control theory and its analysis.
2. Able to solve different system representations using block diagram reduction and Signal Flow techniques.
3. Analysis of Transient and steady state response.
4. Understand the open loop and closed loop frequency responses of systems.
5. Learn stability concept using routh- hurwtiz criterion and root locus.
6. Analysis of stability in Frequency domain with different methods.

SYLLABUS

UNIT-I **[11]**

Introduction

Introduction, Open-loop system and its examples, Closed-loop system and its examples, Open-loop vs Closed-loop

Mathematical Modeling

Modeling of Mechanical system, Modeling of Electronic and electrical system, Modeling of Liquid-level system, Transfer function of system, Modeling in state-space

UNIT-II **[11]**

Block diagram and Signal Flow graph

Block diagram formulation, Block diagram reduction, Signal Flow graph, Mason's Gain formula

Transient response analysis

Standard test signals, First-order and second order systems, Higher order systems, Transient response of system,

UNIT-III **[12]**

Steady State Response Analysis:

Steady-state error for unit, ramp and parabolic inputs, Effect of Proportional, derivative and integral control, MATLAB simulations,

Time domain Stability Analysis

RH stability criteria, Introduction to Root Locus, Rules for constructing the root locus, System analysis with the help of Root-locus, Root-locus plot using MATLAB

UNIT-IV **[11]**

Frequency Response Analysis

Introduction, Specification for frequency response, Polar-plots, Bode plots, Nyquist plots, Stability analysis, MATLAB simulations

Text Books

1. Katsuhiko Ogata, "Modern Control Engineering", 4th Ed, Prentice Hall of India.
2. Benjamin C.Kuo, "Automatic Control Systems", PHI Learning Private Limited, 2010.

Reference Books

1. Norman S Nise, "Control system Engineering", 4th Ed., Wiley-India Edition.
2. I J Nagrath, M Gopals "Control system Engineering", 5th Ed., New Age International Publisher.

Web resources

1. https://onlinecourses.nptel.ac.in/noc19_ee30/

2. https://ocw.mit.edu/courses/mechanical-engineering/2-04a-systems-and-controls-spring-2013/lecture-notes-labs/
3. www3.imperial.ac.uk
4. mitra.ac.in

MOOCs

1. https://www.edx.org/
2. https://www.nptel.ac.in/
3. https://www.coursera.org/

Name of Institute: ITE

Name of Faculty: Dr. Sweta Shah

Course code: EL0416

Course name: Electromagnetics

Pre-requisites: EEE, Maths

Credit points: 4

Offered Semester: 4th

Course Coordinator

Full Name: Dr Sweta Shah

Department with siting location: Electrical, 3rd floor staff room

Telephone: 9979884434

Email: swetashah.el@indusuni.ac.in

Consultation times: 3.45 to 4.20pm

Course Lecturer

Full Name: Dr Sweta Shah

Department with siting location: Electrical, 3rd floor staff room

Telephone: 9979884434

Email: swetashah.el@indusuni.ac.in

Consultation times: 3.45 to 4.20 pm

Students will be contacted throughout the Session via Mail with important information relating to this Course.

Course Objectives

By participating in and understanding all facets of this Course a student will:

1) To understand different types of coordinate systems.
2) To learn the concept of electric flux and flux density for different charge configurations.
3) To learn the concept of electric field intensity for different charge configurations.
4) To understand application of Gauss's law.
5) To understand the concept of divergence.

6) To understand boundary conditions for different boundaries.

Course Outcomes (CO)

1) Able to transform one system to another coordinate system.
2) Able to determine electric and magnetic fields due to specified charge and current distributions.
3) Relate the physical basis of Maxwell's equations in integral form and differential form.
4) Apply Maxwell's equation for the solution of appropriate problems involving static as well as time varying fields.
5) Apply the appropriate electric and magnetic field boundary conditions for a given problem involving their use.
6) Analyze problems involving one-dimensional Poisson's and Laplace's equations.

Course Outline

Proposed course mainly deal with coordinate systems, electrostatic field and magnetic field calculation for different configurations.

Method of delivery

Face to face lectures

Study time

3 lectures + 1 Tutorial per week

CO-PO Mapping (PO: Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	-	-	-	-	-	-	-	-	-
CO2	3		3		-	-	-	1	-	2	-	-
CO3	1	2			-	3	-	1	-	-	2	-
CO4	1	1	3	2	-	-	-	-	-	-	-	-
CO5	1		3	3		-	-	-	-	-	2	-

CO6	1	2	3	3		-	-	-	-	-	2	-

Blooms Taxonomy and Knowledge retention (For reference)

(Blooms taxonomy has been given for reference)

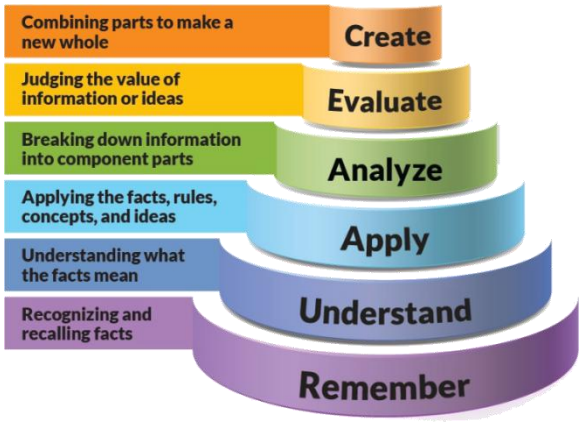


Figure 1: Blooms Taxonomy

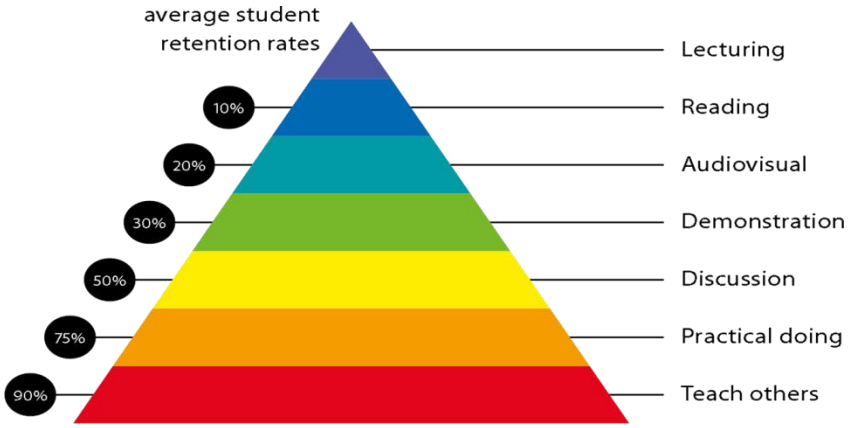


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed	**1 Professional knowledge, grounding &**

Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**awareness**
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:

NA

Lecture/tutorial times

(Give lecture times in the format below)

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the Course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for mid and end semester examinations.

Details of referencing system to be used in written work

Text books

1. Engineering Electromagnetics, W H Hayt, J A buck, 7th Edition, TMH Publication

Additional Materials

1. Electromagnetic Waves & Radiating Systems, Edward C. Jordan, Keith G. Balmain, 2nd Edition, PHI publication.
2. Fields and Waves in Communication Electronics, Simon Ramo, John R. Whinnery, Wiley Publication

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in mid semester or end semester will be considered for supplementary assessment in the respective components (i.e mid semester or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (mid semester or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Practical Work Report/Laboratory Report:

NA.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -1% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

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Do not copy the work of other students.

Do not share your work with other students (except where required for a group activity or assessment)

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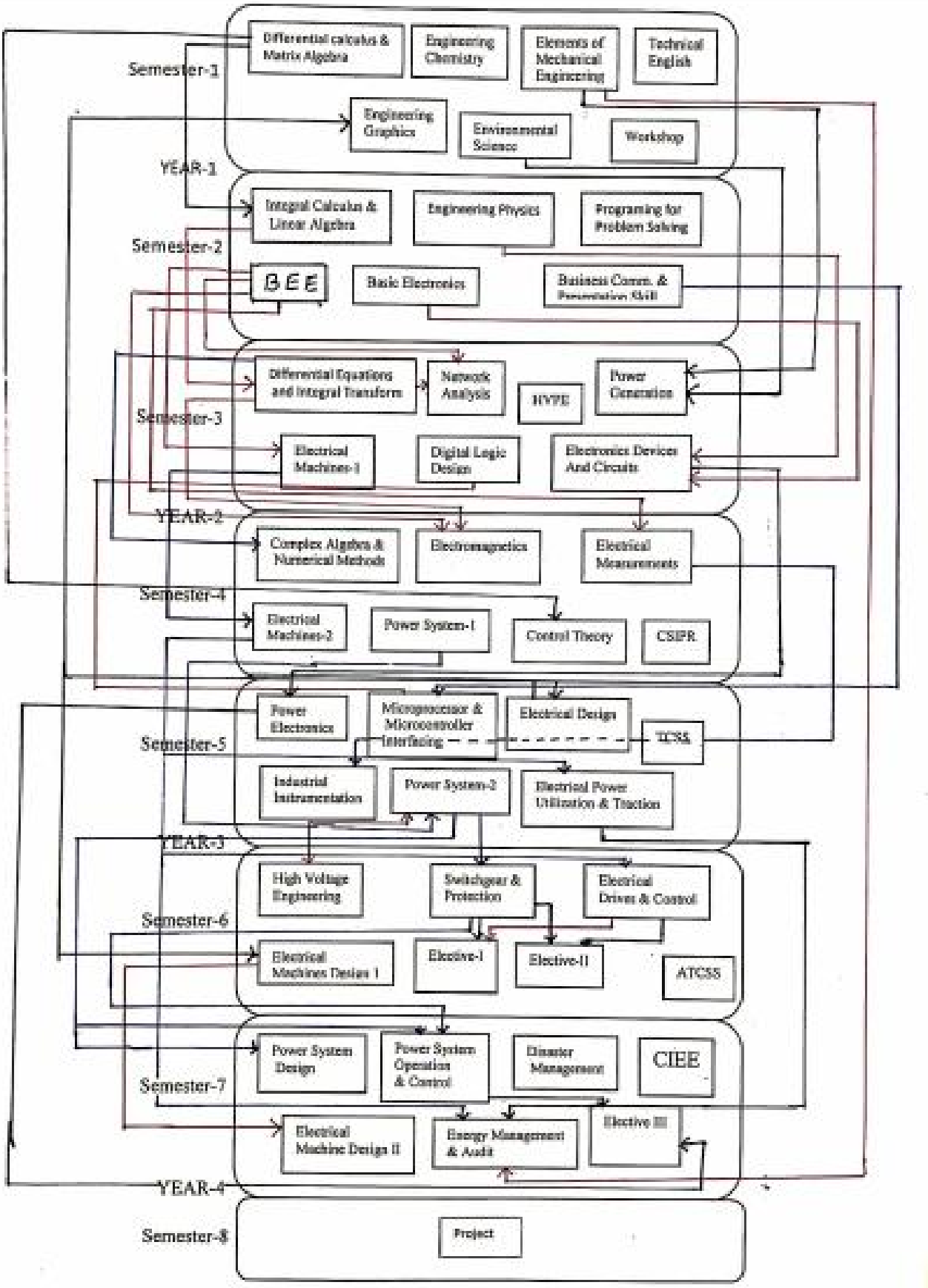
Course schedule (subject to change)

(Mention quiz, assignment submission, breaks etc as well in the table under the Teaching Learning Activity Column)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	Scalars & Vectors, Dot and cross products, scalar and vector projection, unit vector.	1	BB, PPT
	Weeks 2	Cartesian coordinate system, incremental length, incremental volume, incremental surface.	1	BB, PPT
	Week 3	Cylindrical coordinate system, spherical coordinate system, point conversion, vector conversion.	2	BB, PPT
	Week 4	Coulomb's law, Electric field intensity, Field due to continuous volume charge distribution,	2	BB, PPT
	Week 5	Electric field intensity for the field of a Line charge, Field of a surface charge.	2, 3	BB, PPT
	Week 6	Concept of electric flux density, Gauss's law, Divergence of D	3	BB, PPT,
	Week 7	Divergence theorem, Maxwell's first equation, Energy expended in moving a point charge in electric field, Energy and potential.	3	BB, PPT
	Week 8	Potential difference, potential gradient, Dipole, Energy density in electrostatic field.	4	BB, PPT

	Week 9	Current and current density, Relation between J and volume charge density, continuity equation, conductor properties, conductor- free space boundary,	4	BB, PPT
	Week 10	Method of images, capacitance of a boundary condition for perfect dielectric materials, Poisson's and Laplace equation, Uniqueness theorem.	5	BB, PPT
	Week 11	Biot-Savart's law, Ampere's circuital law, Point form of Ampere's circuital law, concept of flux density, Scalar and vector magnetic potential.	5	BB, PPT
	Week 12	Stoke's theorem for magnetic field, Force on a moving charge, Force and torque on a closed circuit	5	BB,PPT
	Week 13	Force between differential current element, Magnetic boundary conditions, normal component and tangential component.	6	BB, PPT
	Week 14	Magnetic circuit, Energy density in magneto static field, Inductance and mutual inductance	6	BB,PPT
	Week 15	Faraday's law, Displacement current, Maxwell's equations in point and integral forms for time varying fields	6	BB, PPT



Elective-I: Advanced Control Theory, Industrial Automation, Soft Computing
Elective-II: Electrical Power Quality, EHV AC & DC, Special Machines, MOOC
Elective-III: FACTS, Advanced Power Electronics, Power System Planning, MOOC

Class Test

EL0416 – Electromagnetics

Marks: 20

1. Explain point conversion and vector conversion from Cartesian system to cylindrical system.

2. Given points A (3, 6,-1), B (2,-2, 4) and C (-1, 3, 1) Calculate
   (a) $R_{AB}.R_{AC}$ (b) The angle between R_{AB} and R_{AC}
   (c) The length of projection of R_{AB} on RAC
   (d) The vector projection of R_{AB} on RAC.

3. A uniform volume charge density of 0.2 μC/m^3 is present throughout the spherical shell extending from r =3 to r =5cm. If $\rho_v = 0$ elsewhere, find the total charge.

4. Derive an expression of electrical field intensity for a field of a line charge.

Quiz

EL0416 – Electromagnetics

Marks:10

Dot product can be used to obtain .....

a) Scalar projection
b) Vector Projection
c) Unit vector
d) Both a and b

Cross product can be used to obtain .....

a) Vector projection
b) Area of triangle
c) Scalar product
d) None of these

Unit of Electric field intensity is

a) Volt
b) v/m
c) coulomb
d) coulomb/m

Gauss's law states that

a) Total flux leaving to the surface is equal to total charge enclosed by the surface.
b) Total charge enclosed by the closed surface is zero.
c) Total charge enclosed by the surface is infinite.
d) Total flux leaving is always higher than charge enclosed.

Cross product of any 2 vector is

a) Scalar
b) Vector
c) Scalar or vector

Unit vector is

a) Vector itself
b) Vector in same direction.
c) Vector with unity magnitude and same direction.
d) Vector with unity magnitude in any direction.

If a vector given in Cartesian coordinate system with Cartesian coordinates to be convert in cylindrical coordinates requires

a) Vector conversion from Cartesian to cylindrical
b) Point conversion from Cartesian to cylindrical followed by vector conversion.

c) Point conversion from cylindrical to Cartesian followed by vector conversion.

d) Only point conversion from Cartesian to cylindrical coordinate system.

Gauss's law states about

a) Electric field intensity

b) Electric flux density

c) Charge configuration

d) None of above

Incremental surface shows

a) Combination of point

b) Combination of incremental length

c) Combination of incremental volume

d) None of above

Tutorial 1

1. Given points A (3, 6,-1), B (2,-2, 4) and C (-1, 3, 1) find

(a) $R_{AB}.R_{AC}$ (b) The angle between R_{AB} and R_{AC}

(c) The length of projection of R_{AB} on RAC

(d) The vector projection of R_{AB} on RAC.

2. Transform each of the following vectors to spherical co-ordinates at the point specified

(a) $5a_x$ at B (r=4, Θ = 25, ϕ = 120)

(b) $5a_x$ at A (x=2, y=3, z= -1)

(c) $4a_x - 2a_y - 4a_z$ at P (x= -2, y= -3, z =4)

3. Given points P (2, 5,-1), Q (3,-2, 4) and R (-2, 3, 1) find

(a) $R_{PQ}.R_{PR}$

(b) The angle between R_{PQ} and R_{PR}

(c) The length of projection of R_{PQ} on R_{PR}

(d) The vector projection of R_{PQ} on R_{PR}.

4. Using coordinate system named, give the vector at point A (2, -1, -3) that extends to B (1, 3, 4)

(a) Cartesian Coordinate system

(b) Cylindrical Coordinate system

(c) Spherical coordinate system

5. Three field quantities are given by P = 2 ax – az, Q = 2 ax – ay + 2az, R = 2 ax – 3 ay + az, Determine

(a) (P + Q) x (P – Q)

(b) Q. (R x P)

(c) P. (Q x R)

(d) Sin $Θ_{QR}$

(e) A unit vector perpendicular to both Q and R.

Tutorial 2

1. Calculate E at M (3, -4, 2) in free space caused by (a) charge Q1 = 2μC at P (0,0,0)

(b) a charge Q2 = 3 μC at Q (-1,2,3) (c) a charge Q1 & Q2.

2. Calculate the total charge within each of the indicated volumes

(a) $0.1 \le x, y, z \le 0.2$, $\rho v = \frac{1}{x^3\, y^3\, z^3}$

(b) $0 \le \rho \le 0.1$, $2 \le z \le 4$, $0 \le \phi \le \pi$, $\rho v = \rho^2 z^2 \sin 0.6\phi$

(c) Universe limit, $\rho v = \frac{e^{-2r}}{r^2}$

3. Find the total charge inside each of the volume indicated

(a) $\rho v = 10\, z^2 e^{-0.1x} \sin\pi y$, $-1 \le x \le 2$, $0 \le y \le 1$, $3 \le z \le 3.6$

(b) $\rho v = 4\, xyz^2$, $0 \le \rho \le 2$, $0 \le \phi \le \pi/2$, $0 \le z \le 3$

(c) $\rho v = 3\pi \cos^2\Theta \cos^2\phi / 2r^2 (r^2 + 1)$, universal limit

4. Given points A (3, 6,-1), B (2,-2, 4) C (-1, 3, 1) and D (2, 3, -4) find

(a) The vector projection of $R_{AB.} + R_{AC}$ on R_{AD} (b) The vector projection of $R_{AB.} + R_{AC}$ on R_{DC}

5. A line charge density ρ_L = 15 nc/m is located in free space on the line y = 3, x=4, and a point charge Q = 2 PC located at the origin. Find

E due to line charge at (8, 9, 10)

E due to point charge at (8, 9, 10)

E due to line and point charge at (8, 9, 10)

Subject: Electromagnetics								
Program: B.Tech. Electrical Engineering				Subject Code: EL0416				Semester: IV
Teaching Scheme				Examination Evaluation Scheme				
Lecture	Tutorial	Practical	Credits	University Theory Examination	University Practical Examination	Continuous Internal Evaluation (CIE)- Theory	Continuous Internal Evaluation (CIE)- Practical	Total
3	1	0	4	40	0	60	0	100

Perquisites:

i) Basic Electrical & Electronics Engineering

ii) Fundamentals of Differential Equations

iii) Fundamentals of multiple integral.

Course Objective:

(i) To understand different types of coordinate systems.

(ii) To learn the concept of electric flux and flux density for different charge configurations.

(iii) To learn the concept of electric field intensity for different charge configurations.

(iv) To understand application of Gauss's law.

(v) To understand the concept of divergence.

(vi) To understand boundary conditions for different boundaries.

(vii) To understand magnetic field and magnetic force.

(viii) To understand the concept of time varying field.

Course Outcome:

CO1: Able to transform one system to another coordinate system.[BT3]

CO-2: Able to determine electric and magnetic fields due to specified charge and current distributions. [BT3]

CO-3: Able to determine potential and energy relationship for different charge configuration.[BT3]

CO-4: Able to evaluate boundary conditions.[BT4]

CO-5: Able to acess electrostatic and electromagnetic laws.[BT5]

CO-6: Access problems involving one-dimensional Poisson's , Laplace's and maxwell's equations, to fulfil the requirements of present day employers,. [BT5]

SYLLABUS

UNIT-I **[12]**

Vector Analysis: Scalars & Vectors, Dot and cross products, Co-ordinate systems and conversions.

Electrostatics I: Coulomb's law, Electric field intensity, Field due to continuous volume charge distribution, field of a Line charge, Field of a Sheet of charge.

UNIT-II **[10]**

Electrostatics II:

Concept of electric flux density, Gauss's law, Divergence of D, Divergence theorem, Maxwell's first eqn., Energy expended in moving a point charge in electric field, Energy and potential , potential difference, potential gradient, Dipole, Energy density in electrostatic field.

UNIT-III **[12]**

Conductors, Dielectrics and Capacitance:

Current and current density, Relation between J and volume charge density, continuity equation, conductor properties, conductor- free space boundary, method of images, capacitance of a boundary condition for perfect dielectric materials, Poisson's and Laplace equation, Uniqueness theorem, Examples.

Steady Magnetic Field:

Biot-Savart's law, Ampere's circuital law, Point form of Ampere's circuital law, concept of flux density, Scalar and vector magnetic potential, Stoke's theorem for magnetic field,

UNIT-IV **[11]**

Magnetic forces, Time varying Field and Maxwell's Equation

Force on a moving charge, Force and torque on a closed circuit, Force between differential current element, Magnetic boundary conditions, Magnetic circuit, Energy density in magneto static field, Inductance and mutual inductance

Faraday's law, Displacement current, Maxwell's equations in point and integral forms for time varying fields

Text Books:

1. Engineering Electromagnetics, W H Hayt, J A buck, 7th Edition, TMH Publication

Reference Books:

3. Electromagnetic Waves & Radiating Systems, Edward C. Jordan, Keith G. Balmain, 2nd Edition, PHI publication.
4. Fields and Waves in Communication Electronics, Simon Ramo, John R. Whinnery, Wiley Publication

Web Resource:

1. nptel.ac.in/downloads/115101005/
2. https://www.studynama.com/.../368-Electromagnetic-Theory-pdf-lecture-notes-ebook..

MOOCS:

i) https://www.edx.org/

ii) https://www.nptel.ac.in/

https://www.coursera.org/

Name of Institute: Indus Institute of Technology & Engineering
Name of Faculty: Dr. Jaydeep Chakravorty

Course code: EL0425
Course name: Electrical Measurements
Pre-requisites:
Basics of Electrical Engineering
Credit points: 05
Offered Semester: IV

Course Coordinator
Full Name: Dr. Jaydeep Chakravorty
Department with siting location: Electrical Engineering Department, 3rd Bhawar Building.
Telephone: 8894420694
Email: el.hod@ indusuni.ac.in
Consultation times: 3:45 – 4:20 p.m.

Course Lecturer
Full name: Dr. Jaydeep Chakravorty
Department with siting location: Electrical Engineering Department, 3rd Bhawar Building
Telephone: 8894420694
Email: el.hod@indusuni.ac.in
Consultation times: 3:45 – 4:20 p.m.

Students will be contacted throughout the Session via Mail with important information relating to this Course.

Course Objectives

By participating in and understanding all facets of this Course a student will:

1) To present a problem oriented introductory knowledge of Electrical measurement techniques.
2) To focus on the study of electrical measurements.
3) Learn the measurement of various electrical parameter in this subject.
4) Learn Measuring equipment, accuracy, range and other parameter of the Meter.
5) Know the construction and application of the instrument transformers.

Course Outcomes (CO)

CO1: Understand the working principal and construction of the measuring instruments and recorders.

CO2: Measure various electrical and physical quantities and parameters using meters and transducers.

CO3. Connection and use of various analog meters.

CO4: Learn the measurement of resistance, inductance and capacitor.

CO5: Learn Measuring of power, energy.

CO6: Know the construction and application of the instrument transformers.

Course Outline

This course mainly deals with different types of Analog meters, like ammeter, voltmeter, wattmeter, energy meter. It explains different techniques for measurement of resistance, inductance and capacitance. It gives an overview of CT and PT.

Method of delivery

Face to face lectures

Study time

3 Hour Lecture and 2 Hour tutorial per week

CO-PO Mapping (PO: Program Outcomes)

Mapping CO's with PO's

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	1	1	1	-	1	-	2	1
CO2	3	2	2	1	1	1	1	-	1	1	2	2
CO3	3	3	3	2	2	1	1	1	1	-	1	2
CO4	3	2	3	3	2	1	1	2	2	-	1	2
CO5	3	3	2	1	1	1	1	-	1	1	-	1
CO6	3	3	3	2	2	1	1	1	1	1	1	1

1-Lightly Mapped 2- Moderately Mapped 3- Highly Mapped

Blooms Taxonomy and Knowledge retention (For reference)

(Blooms taxonomy has been given for reference)

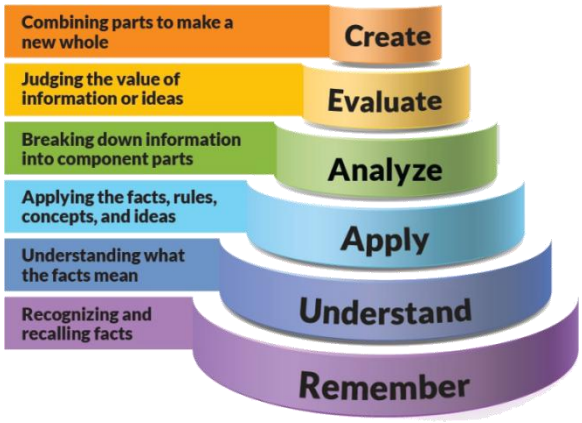


Figure 1: Blooms Taxonomy

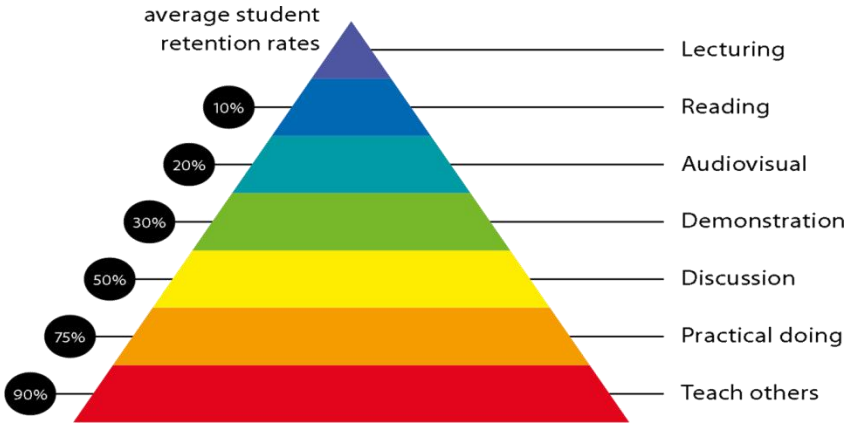


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply	**4 Problem solving skills**

creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:

(Mention what practical work this Course involves)

Lecture/tutorial times

(Give lecture times in the format below)

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the Course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for mid and end semester examinations.

Details of referencing system to be used in written work

Text books

1. Golding E. W. and Widdis F. C., “Electrical Measurements and Measuring Instruments”, 5th Ed., A.H. Wheeler and Company. 1994

Additional Materials

1. Harris F. K., "Electrical Measurement", Wiley Eastern PrivateLimited.1974
2. Stout M. B., "Basic Electrical Measurements", Prentice Hall of IndiaPrivate Limited.1984

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in mid semester or end semester will be considered for supplementary assessment in the respective components (i.e mid semester or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (mid semester or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Practical Work Report/Laboratory Report:

A report on the practical work is due the subsequent week after completion of the class by each group.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

Do not copy the work of other students.

Do not share your work with other students (except where required for a group activity or assessment)

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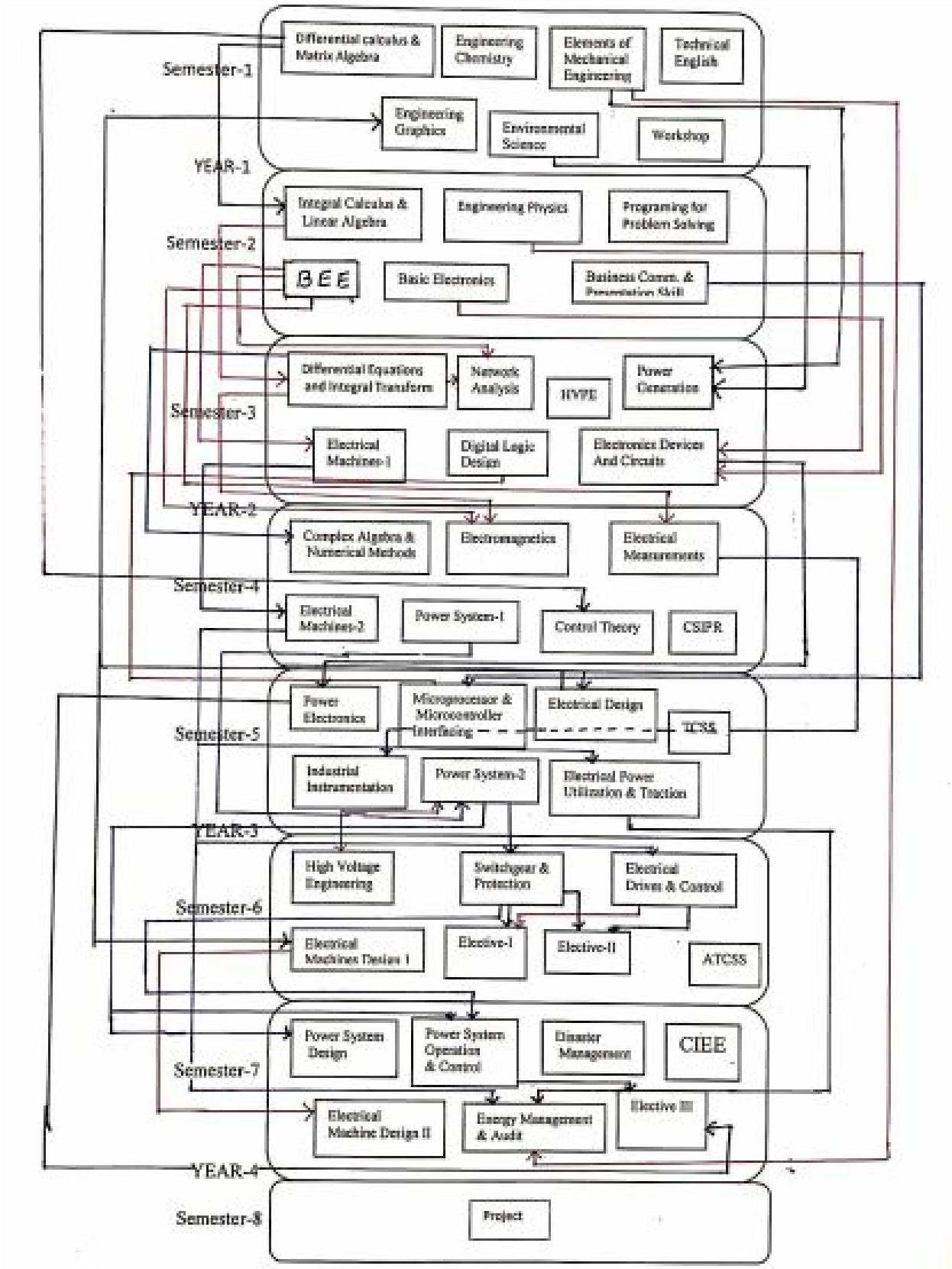
Course schedule (subject to change)

(Mention quiz, assignment submission, breaks etc as well in the table under the Teaching Learning Activity Column)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	SI units, static and dynamic characteristics of electrical instruments Errors in measurement, reproducibility, drift, accuracy and precision, sensitivity, discrimination and resolution. Problem Solving	CO1	Chak & Talk
	Weeks 2	Classification, Principle of operation, operating forces Construction, torque/weight ratio	CO1	Chak & Talk
	Week 3	control system, damping system. Galvanometer equation in dc and ac measurements D ' Arsonval, vibration and ballistic type galvanometers.	*CO1, CO2*	Chak & Talk
	Week 4	D ' Arsonval, vibration and ballistic type galvanometers. Doubt clearing; Problem Solving Types of instruments, PMMC, MI	*CO1, CO2*	Chak & Talk
	Week 5	Electrodynamic, Electrothermic Instruments Hot wire, thermocouple Electrostatic instruments, Rectifier Instruments	*CO1, CO2, CO3*	Chak & Talk
	Week 6	Electrodynamometer and induction wattmeters Errors and their compensation Multi-element wattmeter	*CO5*	Chak & Talk
	Week 7	Induction energy meter Calibration devices, errors and their compensation Poly-phase energy meter, testing	CO5	Chak & Talk
	Week 8	Maximum demand indicator Bi-vector and tri-vector meters Power factor and frequency meters.	CO5	Chak & Talk
	Week 9	Doubt clearing; Problem Solving DC potentiometer	*CO2*	Chak & Talk

	Week 10	Polar and coordinate ac potentiometers Measurement of low, medium and high resistances	*C02*	Chak & Talk
	Week 11	Measurement of low, medium and high resistances Measurement of low, medium and high resistances Wheatstone bridge method	CO4	Chak & Talk
	Week 12	Loss of charge method Kelvin's double bridge method	CO4	Chak & Talk
	Week 13	Doubt clearing; Problem Solving General principles, sensitivity analysis Hay, Owen Heaviside Campbell bridges for inductance;	CO4	Chak & Talk
	Week 14	De Sauty and Wein bridges for capacitance High-voltage Schering Bridge and grounding. CT & PT Construction, phasor diagrams, error analysis and compensation	CO4, CO6	Chak & Talk
	Week 15	CT & PT Construction, phasor diagrams, error analysis and compensation Testing and application of measuring CT and VT	CO4,CO6	Chak & Talk



Elective-I: Advanced Control Theory, Industrial Automation, Soft Computing
Elective-II: Electrical Power Quality, EHV AC & DC, Special Machines, MOOC
Elective-III: FACTS, Advanced Power Electronics, Power System Planning, MOOC

Subject: Electrical Measurement								
Program: B.Tech. Electrical Engineering			**Subject Code: EL0425**				**Semester: IV**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)-Theory**	**Continuous Internal Evaluation (CIE)-Practical**	**Total**
3	0	2	4	16/40	16/40	24/60	24/60	200

Perquisites

i) Basic mathematics

ii) Network analysis

Course Objectives

6) To present a problem oriented introductory knowledge of Electrical measurement techniques.

7) To focus on the study of electrical measurements.

Course Outcome

CO-1: Able to describe the working principal and construction of the measuring instruments and recorders. [BT-1]

CO-2: Able to explain how to measure various electrical and physical quantities and parameters using meters and transducers. [BT-2]

CO-3: Apply various analog meters in various measurements. [BT-3]

CO-4: Classify various methods for the measurement of resistance, inductance and capacitor. [BT-4]

CO-5: Able to measure power, & energy, thus developing skill and employability in studnts [BT-5]

CO-6: Derive and construct instrument transformers for measurement applications. [BT-6]

SYLLABUS

UNIT– I

Potentiometers & Instrument transformers

Principle and operation of D.C. Crompton's potentiometer – standardization – Measurement of unknown resistance, current, voltage. A.C. Potentiometers: polar and coordinate type's standardization – applications. CT and PT – Ratio and phase angle errors

UNIT –II

Measurement of Power & Energy

Single phase dynamometer wattmeter, LPF and UPF, Double element and three element dynamometer wattmeter, expression for deflecting and control torques – Extension of range of wattmeter using instrument transformers – Measurement of active and reactive powers in balanced

systems. Single phase induction type energy meter – driving and braking torques – errors and compensations – testing by phantom loading using R.S.S. meter. Three phase energy meter – tri-vector meter, maximum demand meters.

UNIT – III

DC & AC bridges

Method of measuring low, medium and high resistance – sensitivity of Wheat-stone's bridge – Carey Foster's bridge, Kelvin's double bridge for measuring low resistance, measurement of high resistance – loss of charge method. Measurement of inductance- Maxwell's bridge, Hay's bridge, Anderson's bridge – Owen's bridge. Measurement of capacitance and loss angle –Desaunty's Bridge – Wien's bridge – Schering Bridge.

UNIT-IV

Transducers

Definition of transducers, Classification of transducers, Advantages of Electrical transducers, Characteristics and choice of transducers; Principle operation of LVDT and capacitor transducers; LVDT Applications, Strain gauge and its principle of operation, gauge factor, Thermistors, Thermocouples, Piezo electric transducers, photovoltaic, photo conductive cells, and photo diodes. Measurement of Non-Electrical Quantities: Measurement of strain, Gauge sensitivity, Displacement, Velocity, Angular Velocity, Acceleration, Force, Torque, Temperature, Pressure, Vacuum, Flow and Liquid level.

TEXT BOOKS:

"G. K. Banerjee", "Electrical and Electronic Measurements", PHI Learning Pvt. Ltd., 2nd Edition, 2016

"S. C. Bhargava", "Electrical Measuring Instruments and Measurements", BS Publications, 2012.

REFERENCE BOOKS:

"A. K. Sawhney", "Electrical & Electronic Measurement & Instruments", Dhanpat Rai & Co. Publications, 2005.

"R. K. Rajput", "Electrical & Electronic Measurement & Instrumentation", S. Chand and Company Ltd., 2007.

"Buckingham and Price", "Electrical Measurements", Prentice – Hall, 1988.

"Reissland, M. U", "Electrical Measurements: Fundamentals, Concepts, Applications", New Age International (P) Limited Publishers, 1st Edition 2010.

"E.W. Golding and F. C. Widdis", "Electrical Measurements and measuring Instruments", fifth Edition, Wheeler Publishing, 2011.

Web Resource

1. www.eng.hmc.edu/NewE80/PDFs/BasicElectricalMeasurements2012.pdf
2. nptel.ac.in/downloads/108105053/
3. https://www.youtube.com/watch?v=xLjk5DrScEU
4. https://www.youtube.com/watch?v=EXtfLWBIxHc
5. https://www.youtube.com/watch?v=xLjk5DrScEU&list=PLt5syl71JKf0IacRzLI-02Q_udP4nJiJg

MOOCS:

i) https://www.edx.org/
ii) https://www.nptel.ac.in/
iii) https://www.coursera.org/

Laboratory Experiment List

1. Measurement of low resistance using Kelvin bridge
2. Measurement of inductance using Maxwell bridge
3. Measurement of capacitance using Schering bridge
4. To Study Characteristics of LVDT or Displacement Transducers
5. Measurement of strain and linear range of operation using Strain Gauge transducer
6. Characteristics of Thermocouple temperature transducer.
7. To find the characteristics of thermocouple and to measure the temperature using thermocouple.
8. Proximity sensor and its applications
9. Analyze analog and digital multimeter for various measurements.

Demonstrate functionality of function generator and its use as a test and measurement equipment.

Name of Institute: Institute of Technology & Engineering
Name of Faculty: Rashmi Sharma

Course code: EL0426
Course name: Electrical Machines-II

Pre-requisites:

1) Elements of Electrical Engineering
2) Basics of Electrical Machines

Credit points: 03

Offered Semester: IV

Course coordinator (weeks 01 - 15)
Full name: Rashmi Sharma
Department with siting location: 2nd floor, Bhawar Building
Telephone:
Email: rashmisharma.el@indusuni.ac.in
Consultation times: 3:00 p.m. to 5:00 p.m.

Course lecturer (weeks 01 - 15)
Full name: Rashmi Shrama
Department with siting location: 2nd floor, Bhawar Building
Telephone:
Email: rashmisharma.el@indusuni.ac.in
Consultation times: 9:00 a.m. to 5:00 p.m.

Students will be contacted throughout the Session via Mail with important information relating to this Course.

Course Objectives

By participating in and understanding all facets of this Course a student will:

1) Understand the construction, working principle, equivalent circuit and circle diagram of a 3 and single phase induction motor and synchronous motors.
2) Understand the various starting methods for single phase and three phase Induction motor.
3) Understand the various speed control methods for single phase and three phase Induction motor and synchronous motor.
4) Learn the different operating characteristics of the machines.
5) Understand the applications of the AC motors for different purposes.
6) Understand power requirement and ratings of different machines

Course Outcomes (CO)

1) To learn the basic concepts of three phase induction motor.
2) Equivalent circuit and circle diagram of three and single phase induction motor.
3) Starting methods and speed controlling methods for single and three phase induction motor.
4) Operating characteristics of synchronous motor
5) V curves and hunting and applications of synchronous motor.
6) Calculate the efficiency of the machines.

Course Outline

In this course students will learn about various electrical machines fundamental, which includes single and three phase machines working, their operating characteristic, applications, rating and selection procedure.

UNIT-I
Induction Machines I
Constructional features of wound rotor and squirrel cage induction machine. Qualitative description of working of poly-phase induction machine from rotating field view point; Coupled circuit model of an idealized three-phase machine, voltage equations of the model, equivalent circuit, phasor diagram, circle diagram. Concept of leakage reactance and its importance on machine performance and design; Double-cage and deep-bar squirrel cage rotor induction motor
UNIT-II
Induction Machine II
Generator action, methods of excitation, characteristics. Space and time harmonics and their effect on motor performance. Methods of starting induction motors; Principles of speed control (i)stator voltage control (ii) control of speed of rotating field (iii)control of slip speed (iv) rotor resistance control (v) V/f control. Effect of voltage injection in secondary of slip-ring induction motor, action of commutator as a frequency converter
UNIT-III
Single-phase induction motor: working, double revolving field theory, equivalent circuit, torque-speed characteristic, performance
Synchronous Machines I: Constructional features of salient pole and cylindrical rotor three phase synchronous machine. Generated emf, winding coefficients, harmonics in generated emf, tooth ripples and armature reaction; Coupled circuit model of an idealised salient pole synchronous machine, application of d-q-o transformation, operation under balanced steady state conditions; Power-angle equations of salient pole and cylindrical rotor synchronous machines.
UNIT-IV
Synchronous Machines II: Voltage regulation of salient pole and cylindrical rotor machine,effect of saturation on voltage regulation. Steady state operating characteristic of synchronous motor; V curves and phasor diagram, hunting Parallel operation of synchronous machines, synchronization and load division, synchronous machine on infinite bus, stability and hunting in synchronous machine.

Method of delivery

Face to face lectures

Study time

4Hours Lecture and 2Hours Lab per week

CO-PO Mapping (PO: Program Outcomes)

	PO1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO 12
CO1	3	1	1	-	-	-	-	-	-	-	-	-
CO2	3	2	3	1	-	-	-	-	-	-	-	-
CO3	1	2	3	1	-	-	-	-	-	-	-	-
CO4	1	1	3	2	-	-	-	-	-	-	-	-
CO5	1	2	3	3	2	-	-	-	-	-	-	-
CO6	1	2	3	3	2	-	-	-	-	-	-	-

Blooms Taxonomyand Knowledge retention(For reference)

(Blooms taxonomy has been given for reference)

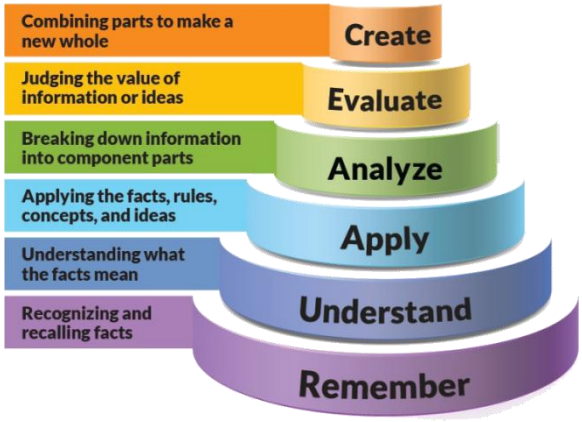


Figure 1: Blooms Taxonomy

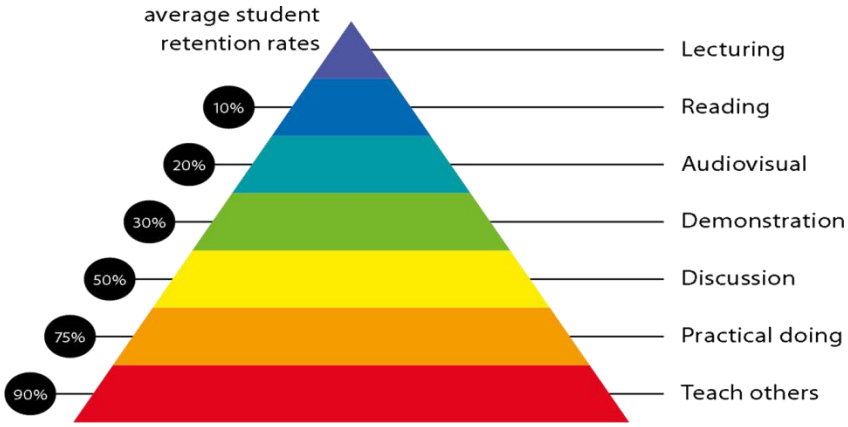


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

1	Three phase induction motor components
2	Star-Delta starter operation of three phase induction motor
3	Direct On-Line Starter in three phase induction motor
4	No load & blocked rotor test on 3-phase induction motor

Practical work:

(Mention what practical work this Course involves)

5	Brake test on 3-phase slip ring induction motor
6	Load test on 3-phase slip ring induction motor
7	No load and blocked rotor test on 1-phase induction
8	To determined speed control of universal motor.
9	To Determine Voltage Regulation of 3 Phase Alternator By Zero Power Factor Method
10	To Plot V and Inverted V Curves of A Synchronous Motor.
11	To Study The Starting & Reversal of Synchronous Motor
12	To Perform Power Factor Correction Using Synchronous Motors.

Lecture/ tutorial times

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the Course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for mid and end semester examinations.

Details of referencing system to be used in written work

Text books

1. Fitzgeraid A. E., Kingsley C. and Kusko A., " Electric Machinery " , 6th Ed., McGraw-Hill International Book Company.2008

2. Say M. G., " The Performance and Design of Alternating CurrentMachines " , CBS Publishers and Distributors.2005

Additional Materials

1. Nagrath I. J. and Kothari D. P., " Electrical Machines " , 3rd Ed., Tata McGraw-Hill Publishing Company Limited. 2004
2. Langsdorf A. S., " Theory of AC machines " , 2nd Ed., Tata McGraw-Hill Publishing Company Limited. 2008

3. Kimbark E.W., " Power System Stability, Vol. III: SynchronousMachines " , Wiley India.2008
4. Chapman S. J., "Electric Machinery Fundamentals", 4th Ed.,McGraw-Hill International Book Company.2005

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

40 marks - mid semester examination
20 marks- internal assessment evaluation

Internal Assessment of 20 marks will include:
Attendance : 05 marks bonus (for all students having attendance >80%)
Presentation: 05 marks
Assignment : 10 marks

End Semester Exam: 40 marks.

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in mid semester or end semester will be considered for supplementary assessment in the respective components (i.e mid semester or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (mid semester or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Practical Work Report/Laboratory Report:

A report on the practical work is due the subsequent week after completion of the class by each group.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment)

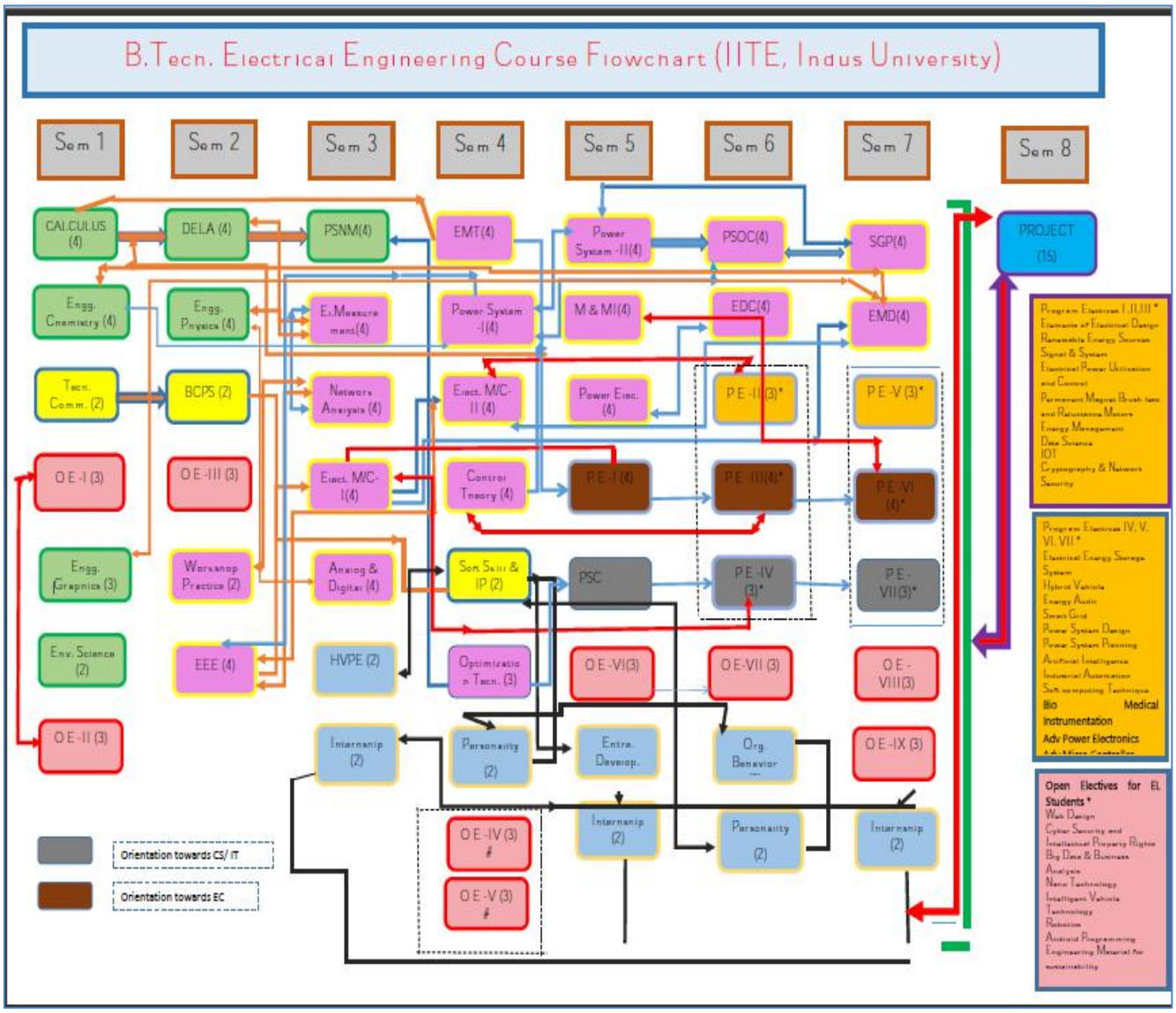
.

Course schedule(subject to change)

(Mention quiz, assignment submission, breaksetcas well in the table under the Teaching Learning Activity Column)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	Constructional features of wound rotor and squirrel cage induction machine. Qualitative description of working of poly-phase induction machine from rotating field view point; Coupled circuit model of an idealized three-phase machine	1,2	BB, PPT
	Weeks 2	voltage equations of the model, equivalent circuit, phasor diagram, circle diagram.	1,2	PPT
	Week 3	Concept of leakage reactance and its importance on machine performance and design; Double-cage and deep-bar squirrel cage rotor induction motor Concept of leakage reactance and its importance on machine performance and design; Double-cage and deep-bar squirrel cage rotor induction motor	*1,2*	PPT
	Week 4	Principles of speed control (i)stator voltage control (ii) control of speed of rotating field (iii)control of slip speed (iv) rotor resistance control (v) V/f control. Effect of voltage injection in secondary of slip-ring induction motor, action of commutator as a frequency converter	1,2	PPT
	Week 5	Single-phase induction motor: working, double revolving field theory, equivalent circuit, torque-speed characteristic, performance	1,2	BB, PPt
	Week 6	Synchronous Machines I: Constructional features of salient pole and cylindrical rotor three phase synchronous machine.	*2,3*	PPT
	Week 7	Generated emf, winding coefficients, harmonics in generated emf, tooth ripples and armature reaction;	2,3	PPT
	Week 8	Coupled circuit model of an idealised salient pole synchronous machine, application of d-q-o transformation, operation under balanced steady state conditions;	2,3	PPT

	Week 9	Power-angle equations of salient pole and cylindrical rotor synchronous machines.	*2,3*	PPT
	Week 10	Synchronous Machines II: Voltage regulation of salient pole and cylindrical rotor machine,effect of saturation on voltage regulation.	4,5	PPT
	Week 11	Steady state operating characteristic of synchronous motor; V curves and phasor diagram, hunting Parallel operation of synchronous machines,	4,5	PPT
	Week 12	synchronization and load division, synchronous machine on infinite bus, stability and hunting in synchronous machine.	4,5	PPT


B.Tech. Electrical Engineering Course Flowchart (IITE, Indus University)
Sem 1
Sem 2
Sem 3
Sem 4
Sem 5
Sem 6
Sem 7
Sem 8
CALCULUS (4)
DELA (4)
PSNM(4)
EMT(4)
Power System -II(4)
PSOC(4)
SGP(4)
PROJECT (15)
Engg. Chemistry (4)
Engg. Physics (4)
E.Measurement(4)
Power System -I(4)
M & MI(4)
EDC(4)
EMD(4)
Tech. Comm. (2)
BCPS (2)
Network Analysis (4)
Elect. M/C-II (4)
Power Elec. (4)
PE-II (3)*
PE-V (3)*
OE-I (3)
OE-III (3)
Elect. M/C-I(4)
Control Theory (4)
PE-I (4)
PE-III(4)*
PE-VI (4)*
Engg. Graphics (3)
Workshop Practice (2)
Analog & Digital (4)
Soft Skill & IP (2)
PSC
PE-IV (3)*
PE-VII(3)*
Env. Science (2)
EEE (4)
HVPE (2)
Optimization Tech. (3)
OE-VI(3)
OE-VII (3)
OE-VIII(3)
OE-II (3)
Internship (2)
Personality (2)
Entre. Develop.
Org. Behavior
OE-IX (3)
OE-IV (3) #
OE-V (3) #
Internship (2)
Personality (2)
Internship (2)
Orientation towards CS/ IT
Orientation towards EC
Program Electives I, II, III *
Elements of Electrical Design
Renewable Energy Sources
Signal & System
Electrical Power Utilization and Control
Permanent Magnet Brush less and Reluctance Motors
Energy Management
Data Science
IOT
Cryptography & Network Security
Program Electives IV, V, VI, VII *
Electrical Energy Storage System
Hybrid Vehicle
Energy Audit
Smart Grid
Power System Design
Power System Planning
Artificial Intelligence
Industrial Automation
Soft computing Techniques
Bio Medical Instrumentation
Adv Power Electronics
Open Electives for EL Students *
Web Design
Cyber Security and Intellectual Property Rights
Big Data & Business Analysis
Nano Technology
Intelligent Vehicle Technology
Robotics
Android Programming
Engineering Material for sustainability

Subject: Electrical Machines-II								
Program: B.Tech. Electrical Engineering				**Subject Code:EL0426**			**Semester: IV**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	2	4	40	40	60	60	200

Perquisites:

(i) Fundamentals of Electrical Engineering

(ii) Electrical Machines -I

Course Objectives:

(i) To learn construction, working principle and applications of Induction motor.

(ii) To understand starting methods and speed control of Induction motor.

(iii) To learn construction, working principle and applications of single phase motors.

(iv) To understand synchronous machine working, features and its applications.

Course Outcome:

CO 1: Explain the fundamental operation and characteristics of Induction motor. [BT-2]

CO 2: Analyze the characteristics features of Induction machine. [BT-4]

CO 3: Describe the working concept and performance of Synchronous motor and single-phase Induction motor. [BT-2]

CO 4: Design and calculate the circuit parameters of Ac Machines, to fulfil the requirements of present day employers, who demand sound engineering skills employability. [BT-6]

CO 5: Calculate the losses and efficiency of the machines. [BT-3]

CO 6: Analyze the performance features and applications of the electrical machines. [BT-4]

SYLLABUS

UNIT-I

Induction Motor **[15]**

Constructional features of wound rotor and squirrel cage induction machine. Qualitative description of working of poly-phase induction machine from rotating field view point; torque slip characteristic and equivalent circuit of induction motor, phasor diagram, effect of slip on rotor circuit, rotor current, rotor torque, starting torque, maximum torque, blocked rotor test and no load test of

induction motor, circle diagram, Double-cage and deep-bar squirrel cage rotor induction motor, Induction generator.

UNIT-II **[15]**

Speed Control of Induction Motor

Different Starters for starting induction motors; Principles of speed control (i)stator voltage control (ii) control of speed of rotating field (iii) control of slip speed (iv) rotor resistance control (v) V/f control. Effect of voltage injection in secondary of slip-ring induction motor, Cogging and crawling of induction motor, braking methods in induction motor.

UNIT-III **[15]**

Single phase motors

Types of single phase motor, revolving field theory, starting and running performance of single phase IM, Split Phase Motors, Capacitor Type Motor, Shaded Pole Induction Motor, Self Starting Synchronous Reluctance Motor, Hysteresis Motor, AC series Motor, Universal Motor, Speed Control of Universal Motors, stepper motor, SRM and servo motors

UNIT-IV **[15]**

Alternators

Construction, Principle of Operation, Method of excitation, armature winding of alternator, winding factor, emf equation of alternator, armature reaction and voltage regulation, alternator on load, parallel operation of alternator.

Synchronous Motor

Construction, Principle of Operation, Starting of synchronous motors, Motor on load with constant excitation and different excitation, Equivalent circuit and phasor diagram, Power developed by a synchronous motor, Effect of Excitation on Armature Current and Power Factor, Construction of V curves, Speed Control of Synchronous Motor, Hunting in synchronous motor, synchronous condensers, Synchronous motor application.

Text Books

1) Fitzgeraid A. E., Kingsley C. and Kusko A., " Electric Machinery " , 6th Ed., McGraw-Hill International Book Company.2008
2) Say M. G., " The Performance and Design of Alternating CurrentMachines " , CBS Publishers and Distributors.2005
3) Bimbhra P.S., Generalized Machine Theory, Khanna Publisher

Reference Books

1) Nagrath I. J. and Kothari D. P., “Electrical Machines ” , 3rd Ed., Tata McGraw-Hill Publishing Company Limited. 2004
2) Langsdorf A. S., “Theory of AC machines ” , 2nd Ed., Tata McGraw-Hill Publishing Company Limited. 2008
3) Kimbark E.W., “ Power System Stability, Vol. III: SynchronousMachines ” , Wiley India.2008
4) Chapman S. J., “Electric Machinery Fundamentals”, 4th Ed.,McGraw-Hill International Book Company.2005

Web resources

1) https://nptel.ac.in/courses/108106072/
2) https://nptel.ac.in/courses/108108076/39
3) https://nptel.ac.in/courses/108106072/pdf/2_6.pdf

MOOCs

i) https://www.edx.org/
ii) https://www.nptel.ac.in/
iii) https://www.coursera.org/

Name of Institute: Institute of Technology and Engineering
Name of Faculty: Prof. Vineeta Chauhan

Course code: EL0417
Course name: Power System -I
Pre-requisites:1) Fundamentals of Electrical Circuits
2) Fundamental of Numerical Methods
Credit points: 04
Offered Semester: 4th

Course Coordinator (weeks 15)
Full Name: Vineeta Chauhan
Department with siting location: 2nd floor, EEE Lab-1, Bhanwar Building
Telephone: 3211
Email: vineetachauhan.el@indusuni.ac.in
Consultation times: Tuesday 3:45 to 4:15pm

Course Lecturer (weeks 15)
Full Name: Rashmi Sharma
Department with siting location: 2nd floor, EEE Lab-1, Bhanwar Building
Telephone: 3211
Email: vineetachauhan.el@indusuni.ac.in
Consultation times: Tuesday 3:45 to 4:15pm

Students will be contacted throughout the Session via Mail with important information relating to this Course.

Course Objectives
By participating in and understanding all facets of this Course a student will:

1) To understand different way of generating electrical energy.
2) To understand different distribution system.
3) To understand different types of tariff.
4) To Understand the economic scheduling of power system

Course Outcomes (CO)

CO 1 -An ability to identify and address current and future electrical engineering problems related to energy sources

CO 2-An ability to identify generation, conversion, transmission, utilization, efficiency, protection, and control within a broader framework of sustainable development.

CO-3 Calculate monthly energy bill as per the tariff of power distribution Company.

CO-4 Learn the transmission line parameter for single phase and three phase system.

CO-5 An ability to identify the characteristics of underground cables.

CO-6 Also know the Mechanical aspects, supply system.

Course Outline

(Key in topics to be dealt)

UNIT-1 **[10]**

Generation, Transmission and Distribution Systems

Fundamentals of Thermal, Gas, Hydro &Nuclear power Station, Electrical supply system, comparison of AC and DC systems, overhead versus underground systems, choice of working voltages for transmission and distribution transmission and distribution system architecture, cost comparison of overhead and underground systems.

UNIT-II
[10]

Load on Power Station

Structure of power system, Types of load, Variable load on power station, Load curve, important terms and factors, load duration curve, selection of generating units, base load and peak load, interconnected grid system.

Economics of power generation & Tariff:

Cost of electrical energy, Expressions for cost of electrical energy, Methods of depreciation, Cost analysis of power plants, types of tariffs- flat rate, block rate, two-part and three-part, fixed and running charges, comparison of tariffs and computation of monthly/annual bill.

UNIT-III **[12]**

Overhead Transmission Lines:

Components of overhead line, line support, types of conductors; Overhead line insulators, types of insulators- pin, suspension and strain insulators, insulator materials, insulator string; Calculation of voltage distribution and string efficiency, methods of equalizing voltages, use of guard rings, sag in overhead lines, calculation of sag with equal level support and unequal level support with effect of wind and ice loading.

Corona:

Theory of corona formation, factors affecting corona, calculation of potential gradient, merits and demerits of corona.

UNIT-IV **[13]**

Line Parameters:

Inductance of a single phase 2 wire line, conductor types, Flux linkage of one conductor in a group,

Inductance of a composite conductor lines, Transposition, Inductance of a three phase lines, Double circuit three phase lines, bundled conductors, skin effect, proximity effect, Capacitance of a 2 wire line, Capacitance of a three phase line with equilateral spacing and unsymmetrical spacing, effect of earth on transmission line capacitance, method of GMD, Potential Gradient.

Underground Cables and their Characteristics:
Elements of a power cable, properties of the insulation and sheath materials, classification of power cables: belted, screened and pressure cables, dielectric stress in cable insulation, grading of cables: capacitance grading and inter-sheath grading, measuring capacitances and charging current in a cable, HVDC cables, faults in AC & DC cables.

Method of delivery
Face to face lectures, Assignments, Tutorials

Study time
3Hours Lecture and 2 Hours Practical per week

CO-PO Mapping (PO: Program Outcomes)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	1	1	-	2	-	-	-	-	-	-	-
CO2	3	2	3	1	-	2	1	1	1	1	1	2
CO3	1	2	3	1	2	2	1	1	-	-	-	-
CO4	1	1	3	2	-	-	1	-	-	2	3	2
CO5	1	2	3	3	2	-	1	-	-	-	-	2
CO6	1	2	3	3	2	-	1	-	-	-	-	2

1-Lightly Mapped 2- Moderately Mapped 3- Highly Mapped

Blooms Taxonomy and Knowledge retention (For reference)
(Blooms taxonomy has been given for reference)

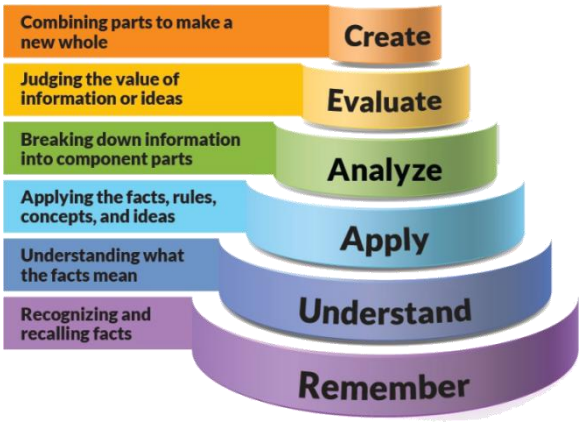


Figure 1: Blooms Taxonomy

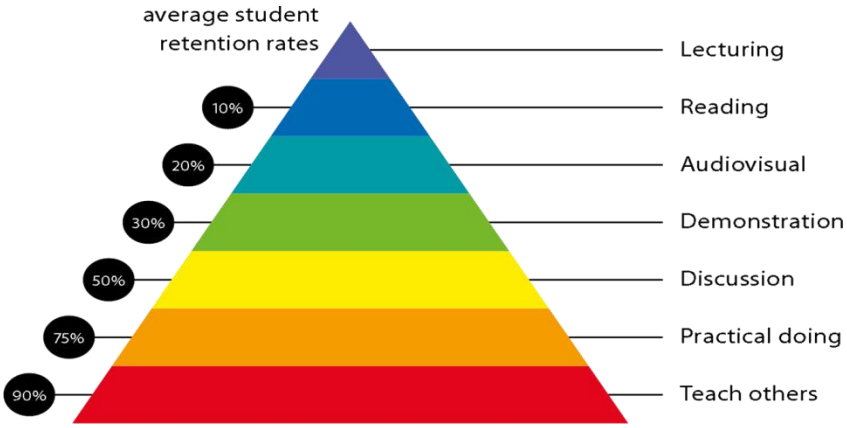


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of Electrical Engineering Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to	**4 Problem solving skills**

respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:

Assessment will be done on the basis of performance based on Experiment Conduction, Lab Manual Writing , Viva – Voice .

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the Course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for mid and end semester examinations.

Details of referencing system to be used in written work

Text books

1. Weedy B.M. and Cory B.J., "Electric Power Systems", 4th Ed.,Wiley India.**2008**
2. Grainger J. J. and Stevenson W.D., "Elements of Power System Analysis", Tata McGraw-Hill Publishing Company Limited.**2008**

Additional Materials

Reference books

1. Gonen T., "Electric Power Transmission System Engineering: Analysis and Design", John Wiley and Sons.**1990**
2. Nagrath I. J. and Kothari D. P., "Modern Power System Analysis", 3rd Ed., Tata McGraw-Hill Publishing Company Limited. **2008**
3. Roy S., "Electrical Power System- Concepts, Theory and Practices", Prentice Hall of India Private Limited. **2007**

Web Resource

1. nptel.ac.in/downloads/108101040/
2. www.erforum.net/

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following (Theory)

Mid Sem (20 marks) Assignment (20 marks) Class Participation (10 marks)

CIE Evaluation (Practical)

File Work (10 marks) Lab Participation (20 marks) Project / Presentation (20 marks) Viva – Voice (10 marks)

LIST OF EXPERIMENTS

1. To measure characteristics of transmission line.
2. To measure attenuation of transmission line.
3. To measure input impedance of the transmission line.
4. To plot phase displacement between the current and voltage at input of the line.
5. To plot phase displacement between the current and voltage at input of the line.
6. To study the classification of overhead transmission lines and measure voltage regulation and efficiency of the lines.
7. To Study medium transmission line model and to obtain the performance calculation of different methods used in medium transmission lines.
8. To measure ABCD constants for transmission lines.
9. To study and obtain the performance calculations of Ferranti Effect in power system.
10. 10)Study of cables and its internal construction.

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in mid semester or end semester will be considered for supplementary assessment in the respective components (i.e mid semester or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (mid semester or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Practical Work Report/Laboratory Report:

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Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment.

Course schedule (subject to change)

(Mention quiz, assignment submission, breaks etc as well in the table under the Teaching Learning Activity Column)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	Fundamentals of power plants ,Overview of Transmission and Distribution Systems, Electrical supply system and its one line diagram, comparison of AC and DC systems	1,2	*ppt*
	Weeks 2	overhead versus underground systems, choice of working voltages for transmission and distribution transmission and distribution system architecture	1,2	*ppt*
	Week 3	choice of working voltages for transmission and distribution transmission and distribution system architecture cost comparison of overhead and underground systems	1,2	*ppt*
	Week 4	Structure of power system, Types of load, Variable load on power station, Load curve, important terms and factors, load duration curve, load duration curve, selection of generating units	1,2	*ppt*
	Week 5	Cost of electrical energy, Expressions for cost of electrical energy, Methods of depreciation base load and peak load, interconnected grid system. Examples	1,2	*ppt*
	Week 6	Cost analysis of power plants, types of tariffs- Examples	1,2	*ppt*
	Week 7	fixed and running charges, comparison of tariffs and computation of monthly/annual bill. flat rate, block rate, two-part and three-part,	1,2	*ppt*
	Week 8	Overhead line insulators, types of insulators- pin, suspension and strain insulators, insulator materials,	3,4	*ppt*
	Week 9	insulator string; Calculation of voltage distribution and string efficiency,	3,4	*ppt*

	Week 10	sag in over head lines, Examples methods of equalizing voltages, use of guard rings,	3,4	*ppt*
	Week 11	Examples calculation of sag with equal level support and unequal level support with effect ofwind and ice loading.	3,4	*ppt*
	Week 12	Examples Theory of corona formation, factors affecting corona, calculation of potential gradient, merits and demerits of corona.	3,4	*ppt*
	Week 13	Inductance of a single phase 2 wire line, conductor types, Flux linkage of one conductor in a group, Inductance of a composite conductor lines, Transposition, Inductance of a three phase lines, Double circuit three phase lines, bundled conductors, skin effect, proximity effect, Capacitance of a 2 wire line, Capacitance of a three phase line with equilateral spacing and unsymmetrical spacing	3,4	*ppt*
	Week 14	Examples effect of earth on transmission line capacitance, method of GMD, Potential Gradient. Elements of a power cable, properties of the insulation and sheath materials, classification of power cables: belted, screened and pressure cables dielectric stress in cable insulation,	3,4	*ppt*
	Week 15	Examples measuring capacitances and charging current in a cable, HVDC cables, faults in AC & DC cables. grading of cables: capacitance grading and inter-sheath grading,	3,4	*ppt*

SYLLABUS

Subject: Power System-I								
Program: B.Tech. Electrical Engineering				Subject Code: EL0417				Semester: IV
Teaching Scheme				Examination Evaluation Scheme				
Lecture	Tutorial	Practical	Credits	University Theory Examination	University Practical Examination	Continuous Internal Evaluation (CIE)- Theory	Continuous Internal Evaluation (CIE)- Practical	Total
3	0	2	4	40	40	60	60	200

Perquisites:

i) Fundamental of Electrical circuits

ii) Fundamental of Numerical methods.

Course Objective:

i) To understand different way of generating electrical energy.

ii) To understand different distribution system.

iii) To understand different types of tariff.

iv) To Understand the economic scheduling of power system

Course Outcome:

CO-1: Identify and address current and future electrical engineering problems related to energy sources.[BT1]

CO-2: Identify generation, conversion, transmission, utilization, efficiency, protection, and control within a broader framework of sustainable development.[BT1]

CO-3: Calculate monthly energy bill as per the tariff of power distribution Company.[BT3]

CO-4: Explain the transmission line parameter for single phase and three phase system.[BT1]

CO-5: Identify the characteristics of underground cables.[BT1]

CO-6: Describe the Mechanical aspects, supply system, helping to develop skills to impart practical knowledge in real time solutions.[BT1]

SYLLABUS

UNIT-1 **[10]**

Generation, Transmission and Distribution Systems

Fundamentals of Thermal,Gas,Hydro &Nuclear power Station, Electrical supply system, comparison of AC and DC systems, overhead versus underground systems, choice of working

voltages for transmission and distribution transmission and distribution system architecture, cost comparison of overhead and underground systems

UNIT-II **[10]**

Load on Power Station

Structure of power system, Types of load, Variable load on power station, Load curve, important terms and factors, load duration curve, selection of generating units, base load and peak load, interconnected grid system.

Economics of power generation & Tariff:

Cost of electrical energy, Expressions for cost of electrical energy, Methods of depreciation, Cost analysis of power plants, types of tariffs- flat rate, block rate, two-part and three-part, fixed and running charges, comparison of tariffs and computation of monthly/annual bill.

UNIT-III **[12]**

Overhead Transmission Lines:

Components of overhead line, line support, types of conductors; Overhead line insulators, types of insulators- pin, suspension and strain insulators, insulator materials, insulator string; Calculation of voltage distribution and string efficiency, methods of equalizing voltages, use of guard rings, sag in overhead lines, calculation of sag with equal level support and unequal level support with effect of wind and ice loading.

Corona:

Theory of corona formation, factors affecting corona, calculation of potential gradient, merits and demerits of corona.

UNIT-IV **[13]**

Line Parameters:

Inductance of a single phase 2 wire line, conductor types, Flux linkage of one conductor in a group, Inductance of a composite conductor lines, Transposition, Inductance of a three phase lines, Double circuit three phase lines, bundled conductors, skin effect, proximity effect, Capacitance of a 2 wire line, Capacitance of a three phase line with equilateral spacing and unsymmetrical spacing, effect of earth on transmission line capacitance, method of GMD, Potential Gradient.

Underground Cables and their Characteristics:

Elements of a power cable, properties of the insulation and sheath materials, classification of power cables: belted, screened and pressure cables, dielectric stress in cable insulation, grading of cables: capacitance grading and inter-sheath grading, measuring capacitances and charging current in a cable, HVDC cables, faults in AC & DC cables.

Text Books:

i) Weedy B.M. and Cory B.J., "Electric Power Systems", 4th Ed.,Wiley India.**2008.**

ii) Grainger J. J. and Stevenson W.D., "Elements of Power System Analysis", Tata McGraw-Hill Publishing Company Limited.**2008**

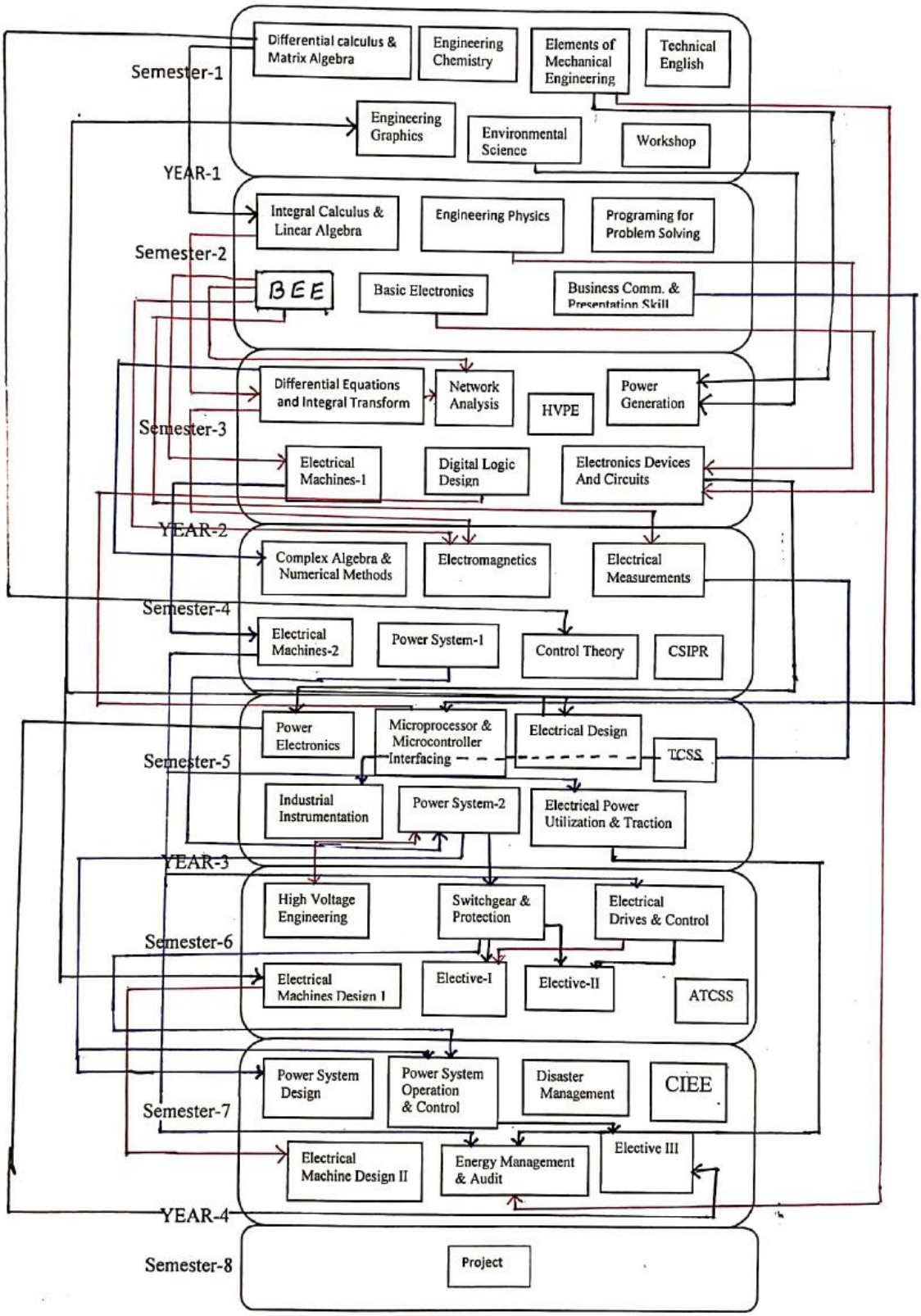
Reference Books

i) Gonen T., "Electric Power Transmission System Engineering: Analysis and Design", John Wiley and Sons.**1990.**

ii) Nagrath I. J. and Kothari D. P., "Modern Power System Analysis", 3rd Ed., Tata McGraw-Hill Publishing Company Limited. **2008.**

iii) Roy S., "Electrical Power System- Concepts, Theory and Practices", Prentice Hall of India Private Limited. **2007.**

iv) V.K. Mehta and Rohit Mehta ,"Principles of power system" , S Chand & Co.Ltd



Elective-I: Advanced Control Theory, Industrial Automation, Soft Computing
Elective-II: Electrical Power Quality, EHV AC & DC, Special Machines, MOOC
Elective-III: FACTS, Advanced Power Electronics, Power System Planning, MOOC